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# OPTIMAL IMPORT QUOTAS IN OLIGOPOLISTIC PROCESSED FOOD MARKETS

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**Abstract**

Recent developments in international trade theory suggest that, where markets are imperfectly competitive, there may be a justification for protectionism. This has come to be widely known as strategic trade policy. There has, however, been little consideration of the applicability of these arguments to agricultural trade. Since trade in processed food products is the most dynamic sector of agricultural trade and given that these markets are typically characterised (to varying degrees) by imperfect competition, it may nevertheless be the case that these recent theoretical developments may have some relevance for the use of protectionism in processed food markets. This paper, therefore, considers the use of import restrictions as a means of increasing national welfare with the U.S. cheese processing sector chosen as a case-study. Using a computable partial equilibrium model, the results suggest that the U.S. government could increase national welfare by using import quotas to protect its cheese processing sector; however, compared with the quota regime currently in use, the optimal import restrictions are more liberal in terms of the level of imports permitted.

# Optimal Import Quotas in Oligopolistic Processed Food Markets

## Introduction

A large proportion of the world's trade in food and agricultural products now occurs in high-value processed products, e.g. processed meat, cheese products, processed fruit and tobacco products. In the 1960s, bulk commodities and processed products accounted for roughly equal shares of agricultural trade, but by the late 1980s the share of processed products had increased to 60 per cent of world trade whilst the share of bulk commodities had fallen to 20 per cent, the remainder being accounted for by intermediate products (FAO). Also, a considerable proportion of trade in processed products now occurs in markets which are not perfectly competitive given the prominent role of state marketing boards, multinational firms and firms involved in food processing (see McCalla, Handy and MacDonald and Elleson for discussion).

In this context, it is relevant to consider recent developments in the international economics literature which have focussed on the impact of imperfect competition in international markets. In particular, a theoretical rationale has been given for the use of protectionism or what have been termed strategic trade policies. Whilst imperfect competition has been incorporated into agricultural trade analysis, strategic trade policy has largely been ignored, the principal exception to this being the recent work of Thursby and Krishna and Thursby who have focussed on markets where state marketing boards are important participants in agricultural trade. This paper extends such analysis to trade in high-value food products where the source of imperfect competition is the existence of oligopolistic food industries. An important implication of these recent theoretical developments is that current protectionist practices should be judged against the benchmark of optimal levels of protectionism where trade restrictions may be justified (at least in a nationalistic sense) rather than the ideal of free trade that is commonly assumed. In this context, this paper analyses the import quota regime used by the US to protect its cheese

processing sector against foreign competition, originating mainly from the European Community (EC). Thus, the welfare effects of the current quota restrictions are compared with optimal import quotas that maximise national welfare.

The paper is outlined as follows: Section 1 summarises the arguments for active trade policy where markets are imperfectly competitive. Section 2 presents a theoretical framework where the emphasis is on optimal import quotas in oligopolistic markets rather than on optimal tariffs and export subsidies, the main instruments used in strategic trade theory. The application of the theoretical model to the US cheese processing sector is presented in Section 3, while Section 4 concludes the paper with suggestions for future research in this area.

**1. Trade Policy and Imperfect Competition**

The standard justification for strategic trade policy is that of "rent-shifting" (see for example, Brander and Spencer, 1985, and Dixit 1984). The basic idea is that a government can alter the nature of competition between firms for monopoly rents in imperfectly competitive markets. Hence, in a quantity-setting framework, it can be shown that export subsidies and tariffs can increase the welfare of exporters and importers respectively. Brander and Spencer, who pioneered this argument, also show that in the absence of cooperation, both governments have an incentive to intervene, the structure of the policy game being similar to the Prisoner's Dilemma.

Although imperfect competition in international trade has received some attention from agricultural economists, this has focussed on either the role of government interactions in trade, e.g. see Schmitz, McCalla, Mitchell and Carter, or the presence in international markets of intermediaries such as marketing boards, e.g. see Just, Schmitz and Zilberman. Recently, however, Thursby has applied the Brander and Spencer-type arguments to agricultural trade in

third-country markets where the emphasis is on state marketing boards. In this paper, however, the role of oligopolistic food industries is considered, as is the case of quantitative restrictions on trade rather than on policies directly influencing prices (i.e. tariffs and export subsidies).

## 2. Theoretical Framework

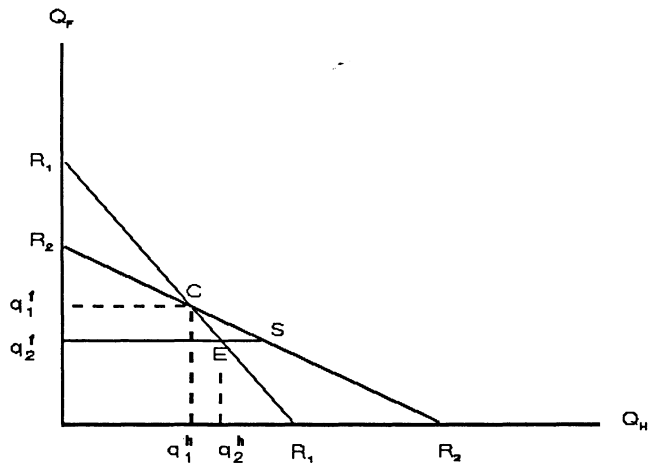
### (i) Import Quotas in Oligopolistic Markets

In order to compare the welfare effects of import quotas currently used to protect US cheese processing with the level of restriction implied by strategic trade theory, it is first necessary to consider the role of import quotas as welfare-enhancing trade instruments in oligopolistic markets. Typically, the literature has considered the role of tariffs and export subsidies as a means of increasing national welfare, though the effect of quotas in a price-setting framework (Bertrand) has been studied by Harris and Krishna. The only study to consider import quotas in a quantity-setting framework has been the recent work by Fung.

The use of import quotas in oligopolistic markets can best be described using a reaction function diagram. It is assumed that two firms (home and foreign) compete in the domestic market each firm employing a quantity-setting strategy, i.e. each firm chooses output to maximise profit, given the output of the competing firm. In **Figure 1**, $R_1R_1$ and $R_2R_2$ are the home and foreign firms' reaction functions respectively. Standard stability conditions on the reaction functions are assumed. In the absence of government intervention, the Nash equilibrium is at C (the Cournot equilibrium). However, national welfare can be increased (assuming no retaliation) if the home government use trade policies that are consistent with the Stackelberg outcome, i.e. where the home firm's highest iso-profit function is just tangential to the foreign firm's reaction function at S. In terms of Figure 1, this would imply a new equilibrium at point E, where exports by the foreign firm are now restricted to $q_2^f$ and the home firm's output increases

from $q_1^h$ to $q_2^h$. The foreign reaction function is now kinked, implying that imports cannot increase beyond $q_2^f$. The new equilibrium is consistent with a lower iso-profit function for the foreign firm and a higher iso-profit function for the domestic firm. In this framework, therefore, if there is no retaliation, import quotas can increase national welfare.

**Figure 1 Import Quotas in a Quantity-Setting Framework**




Clearly, if import quotas are actually a feature of a particular market, there is an argument for comparing the actual level of import restriction with the optimal quota consistent with the above theoretical framework. For example, if actual import quotas are above (below) the $q_2^f$ level of imports, the framework suggests that national welfare could be increased by tightening (liberalising) the level of imports allowed under the current quota regime. Before considering this application to the US cheese processing sector, it is first necessary to derive a more explicit formulation for the optimal quota restriction.

(ii) Theoretical Model

The theoretical model used in this paper follows that of Dixit (1988). A situation is considered where domestic producers of a processed agricultural product compete with imports, the essential

features of the model being the use of a general conjectural variations approach, where the conjectural variations parameters are left free, allowing different forms of oligopolistic behaviour; firms' costs are assumed to be constant; home produced goods (subscript 1) and imported goods (subscript 2) are treated as imperfect substitutes.

Focussing on the home market, consumer surplus is given by:

(1) $$\Gamma = f(Q_1,Q_2) - p_1Q_1 - p_2Q_2$$

where the utility function $f(Q_1,Q_2)$ is defined as:

(2) $$f(Q_1,Q_2) = a_1Q_1 + a_2Q_2 - \frac{1}{2}(b_1Q_1^2 + b_2Q_2^2 + 2kQ_1Q_2)$$

From (1) and (2) the inverse demand functions for the home produced and imported goods can be derived:

(3) $$p_1 = a_1 - b_1Q_1 - kQ_2$$

(4) $$p_2 = a_2 - kQ_1 - b_2Q_2$$

where all parameters are positive, $b_1b_2 - k^2 > 0$ since the products are imperfect substitutes, $p_1$ and $p_2$ are prices and $Q_1$ and $Q_2$ are quantities.

On the supply side, there are $n_i$ firms in the home and foreign economies. Profits for a representative firm in each country are given by:

(5) $$\pi_1 = (p_1 - c_1)q_1 - f_1$$

(6) $$\pi_2 = (p_2 - c_2 - r)q_2 - f_2$$

where prices and quantities are as defined above, $c_i$ and $f_i$ are marginal and fixed costs respectively and r is rent per unit of import which is assumed to be captured by the home government through selling quota licences.

As noted earlier, the model is one where firms' reactions to one another are treated as a Nash equilibrium with conjectural variations. The conjectural variations parameters are derived from the first-order conditions of the respective profits functions:

(7) $$p_1 - c_1 + q_1 dp_1/dq_1 = 0$$

(8) $$p_2 - c_2 - r + q_2 dp_2/dq_2 = 0$$

where $dp_i/dq_i$ is the conjectural variations parameter, i.e. the firm's expectation of how market prices will vary with changes in its output. Therefore, if a representative firm plays Cournot, it believes rival firms will not change output in response to a change in $q_i$, hence $dp_i/dq_i = -b_i$, the slope of the inverse demand function. If the market were perfectly competitive, a change in one firm's output would have no effect on market price, i.e. $dp_i/dq_i = 0$.

Aggregating over the $n_i$ firms generates:

(9) $$p_1 - c_1 + Q_1 V_1 = 0$$

(10) $$p_2 - c_2 - r + Q_2 V_2 = 0$$

where $V_i$ is the aggregate conjectural variations parameter. Thus, for Cournot behaviour, $V_i = -b_i/n_i$ and as $n_i$ increases, the more competitive the Cournot outcome becomes. In the limit $V_i = 0$, i.e. perfect competition. The $V_i$ can be calculated for a particular equilibrium given data on prices, quantities and costs.

Equilibrium prices and quantities in the model are obtained by combining (3) and (4) with (9) and (10), the explicit solutions for quantities being:

(11) $$\begin{bmatrix} Q_1 \\ Q_2 \end{bmatrix} = \frac{1}{\Delta'} \begin{bmatrix} b_2 + V_2 & -k \\ -k & b_1 + V_1 \end{bmatrix} \begin{bmatrix} a_1 - c_1 \\ a_2 - c_2 - r \end{bmatrix}$$

where $\Delta' = (b_1 + V_1)(b_2 + V_2) - k^2 = (\beta_1 \beta_2 - k^2)$, $\beta_i = (b_i + V_i)$.

(iii) Optimal Quota Policy

The government's objective is to choose a policy to maximise national welfare, which is the sum of consumer surplus Γ, domestic firms' profits and government revenue as given by:

(12) $$W = \Gamma + Q_1(p_1 - c_1) + rQ_2$$

where r is the per unit quota rent. Substituting in for Γ from (1), (12) can be re-written as:

(13) $$W = f(Q_1,Q_2) - c_1Q_1 - p_2Q_2 + rQ_2$$

Assuming that firm's conjectures and the demand parameters are unaffected by government policies, the optimal quota policy is derived by maximising (12) with respect to $Q_2$, subject to the constraint:

(14) $$p_1 = c_1 + Q_1V_1$$

Using (2), (3), (4) and (14) the first-order condition for maximisation is:

(15) $$\frac{\delta W}{\delta Q_2} = -(a_1 - b_1Q_1 - c_1)/(k/b_1 + V_1) + b_2Q_2 - c_2 + r$$

Given that $Q_1$ and $Q_2$ are endogenous following the imposition of policy, (15) can be solved by substituting in explicit expressions for $Q_1$ and $Q_2$, as given by (11). Hence (15) can be re-written as:

(16) $$\overline{Q_2} = (a_1 - c_1)\left[\frac{b_2k}{\mu\beta_1\beta_2} + \frac{\zeta\beta_2}{\Delta'\mu\theta}\right] + (p_2 - c_2)\left[\frac{kV_2\zeta}{\Delta'\mu\theta(1-V_2)} - \frac{1}{b_2(1-V_2)\mu}\right]$$

$$+ a_2\left[\frac{\zeta kV_2}{\Delta'\mu\theta(1-V_2)} + \frac{V_2}{b_2(1-V_2)\phi\mu}\right] + \frac{c_2}{b_2\phi\mu}$$

$\bar{Q}_2$ is the optimal level of quota, where:

$$\beta_i = (b_i + V_i) \quad ; \quad \Delta' = \beta_1\beta_2 - k^2 \quad ; \quad \phi = \left(1 - \frac{V_2}{1-V_2}\right)$$

$$\zeta = \left(\frac{kV_2}{b_2(1-V_2)\theta} - \frac{b_1 b_2 k}{\beta_1 \theta}\right) \quad ; \quad \theta = \left(1 + \frac{k^2 V_2}{\Delta'(1-V_2)}\right) \quad ; \quad \mu = \left(1 + \frac{k b_2 V_2}{1-V_2}\right)$$

**3. Optimal Import Quotas and the US Cheese Processing Sector**

The theoretical results derived in Section 2 are applied to the US cheese processing sector. A case-study of this sector is interesting since the US government has protected it with import quotas since 1951 (see Hornig for a useful discussion). Furthermore, the strategic trade policy rationale can usefully be applied to this sector since, in both the US and EC (the main competitor), cheese processing industries are to varying degrees imperfectly competitive. Since import quotas currently affect the US market, the theoretical framework is used to compare the welfare outcome of the optimal import quota with the quota regime currently in use.

The empirical results are derived using a computable partial equilibrium model. As details of this model are discussed elsewhere, (Dixit, 1987), a full outline of the model is not presented here. Nevertheless, it should be noted that the structure of the model is identical with the theoretical framework outlined above. Values for the various parameters are attained by calibrating the model with data from external sources such that the parameter values are consistent with equilibrium in a given period.

The model was calibrated for the year 1980. Since there are many varieties of processed cheese available, blue-vein cheese was chosen as a particular example. The basic reason for this choice was that blue-vein cheese is mainly exported by private firms in the EC. In contrast, other

cheeses tend to be exported by marketing boards and other organisations, hence the objectives of these firms may not be consistent with the theoretical framework outlined in Section 2. The relevant price and quantity data were derived from USDA Dairy Market Statistics, USDA Dairy Products and USDA Foreign Agricultural Trade[1].

The empirical model was used to derive the optimal level of import quotas for 1980 using (16). The optimal quota was compared with the actual quota imposed in 1980, the results being presented in **Table 1.** The actual and optimal quota levels are also compared with the amount of cheese that would have been imported in the absence of restrictions, which was also derived from the model. The optimal quota suggests that a level of imports of 5.173 m.lbs compared with an actual level of imports of 4.361 m.lbs. These values compare with a level of imports of 6.169 m.lbs that would have entered the US in the absence of any restrictions. The estimates suggest that the quota regime applied in 1980 should have increased imports by 0.812 m.lbs (an increase of 18.6 per cent) in order to be at the optimal level. This optimal level also represents a cut-back in imports of 19.3 per cent relative to estimated free-trade levels.

| **Table 1 Import Quotas: Optimal and Actual, 1980 (lbs)** | |
|---|---|
| Optimal Import Quota | 5,172,999 |
| Actual Quota Supply | 4,360,994 |
| Percentage Change (Optimal/Actual) | 18.6% |
| Imports under Free Trade | 6,169,743 |
| Percentage Change (Optimal/Free Trade | -19.3% |

Of course, optimal quotas in a strategic trade policy context suggest that national welfare can be increased if the optimal level of import restriction is adopted. Thus the welfare effects of adopting an optimal quota compared to the actual quota can also be considered. As outlined

[1] Further details on model calibration and data used are available from the authors on request.

above, national welfare is given by (13), where rent per unit of import, r, is given by:

$$(17) \qquad r = \frac{(a_2 - c_2)\Delta' - \beta_2 \overline{Q}_2 \Delta' - k(\beta_1 a_1 - k a_2 + k c_2 - c_1 \beta_2)}{\beta_1 \beta_2}$$

where $\beta_i$ and $\Delta'$ are as defined and $\overline{Q}_2$ is given by (16). The results of the welfare comparison are presented in **Table 2.**

**Table 2 National Welfare: Optimal versus Actual Import Quotas, 1980 ($m)**

| | Actual Quota | Optimal Quota | No Quota |
|---|---|---|---|
| Consumer Surplus | 29.8 | 30.9 | 32.82 |
| Domestic Firms' Profit | 27.7 | 27.4 | 27.06 |
| Quota Rent | 2.84 | 2.84 | 0 |
| Total Welfare | 60.34 | 61.14 | 59.88 |

The results show that overall welfare could be increased if optimal quotas were adopted. Relative to the free trade case, US welfare could be increased by 2.1 per cent and relative to the actual quotas imposed, optimal quotas could increase welfare in the region of 1.3 per cent. Furthermore, taking into account the fact that this market is imperfectly competitive, the current quota regime apparently increases welfare relative to the free trade case by 0.77 per cent. It should be noted that while the aggregate welfare effects are small, there are nevertheless important redistributional effects: consumers lose from quotas, while the domestic firms and the government gain sufficiently in total to outweigh these losses.

The results are both interesting and provocative. First, there appears to be a case for import quotas in the US cheese processing sector given that the industry can be characterised by some degree of imperfect competition. National welfare can thus be increased if such trade restrictions are adopted, which is consistent with the overall prediction of strategic trade theory.

Second, in relation to the current US import quota regime, the results suggest that the levels are too stringent. This conclusion, to varying degrees, is confirmed for other years for which the model was calibrated.

**Conclusion**

The focus of this paper has been on the applicability of recent developments in international trade theory to agricultural trade. Given that trade in processed agricultural products is increasingly imperfectly competitive in nature, there would appear to be a case, *a priori*, for applying strategic trade theories to particular processed product markets. Choosing the US cheese processing sector as an example, the predictions of strategic trade theory appear to be vindicated; import quotas can increase welfare (albeit marginally so), though the current quota regime operated by the US could increase welfare by even a greater amount if the level of restriction were relaxed.

These theoretical developments would therefore appear to be a challenge for agricultural economists to deal with. The benchmark of free trade may not be, at least from a nationalistic perspective, the appropriate benchmark for analysing protection if markets are imperfectly competitive. A considerable research agenda arises from these theoretical developments: better models of oligopolistic behaviour; the effects of retaliation; more case-studies; and econometric models of particular markets (in place of 'synthetic' partial equilibrium models) are all necessary if the application of strategic trade theory to agricultural trade is to be truly valid.

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